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Evaluating Domestic Wastewater Quality in Khulna City Using Correlation Analysis between Electrical Conductivity and Total Dissolved Solids

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ABSTRACT

Effective wastewater management is essential for protecting the environment and ensuring public health. Untreated or badly treated wastewater can severely pollute water bodies and soil, potentially spreading diseases and compromising drinking water sources. The main objective of this study was to measure pollution in household wastewater in Khulna city. The sample was collected from household Drain & Basin water as wastewater, Drinking water & Surface Water from June to August 2024. 120 samples were collected from Shib Bari More, Tetultola More, Moylapota More, Sonadanga Bus Stand, and the Sonadanga Residential Area. These areas were chosen for wastewater analysis because they are busy and have many activities that produce wastewater. The Regression analysis and correlation were evaluated in the study to demonstrate an empirical relationship between these factors. The electrical conductivity found ranged from 250.5 to 415.0 $\mu\text{S/cm}$, whereas TDS levels found ranged from 110.0 to 236.0 mg/l. The data revealed a significant contamination level in the wastewater, as evidenced by higher conductivity and TDS. The correlation coefficient between the two parameters was found to be 0.93. This correlation shows that Electrical Conductivity (EC) and Total Dissolved Solids (TDS) have a significant linear relationship. The regression analysis showed an increase in electrical conductivity. The TDS concentration increased by 0.85. One of the most important factors in evaluating wastewater quality is the correlation between Electrical Conductivity (EC) and Total Dissolved Solids (TDS), underlining the importance of improved wastewater treatment in developing countries to protect health and the environment.

Keywords: Wastewater Quality, Correlation between EC & TDS, Household Wastewater, Wastewater Management, Khulna City

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1. INTRODUCTION

Water is very significant for all life. Access to clean, safe water is a fundamental human right. Monitoring of Electrical Conductivity (EC) and Total Dissolved Solids (TDS) as parameters of effective water management is essential to guarantee the fulfillment of this right.

Electrical conductivity (EC) measures the electric current from water [1]. TDS evaluates dissolved substances [2]. Both EC and TDS are important for assessing water pollution. Untreated wastewater discharge is a significant environmental and health problem. Untreated wastewater leads to

contamination and health risks, including the spread of diseases like cholera [3]. Proper wastewater management is critical for protecting public health. Adequate wastewater management requires knowledge of water quality to determine the best treatment methods and management strategies. This study focused on Khulna, Bangladesh, analyzing EC and TDS in various water sources, including household Drain & Basin water as wastewater, drinking water, & Surface Water, to examine the correlation between these EC and TDS parameters [4]. Several water sources, including household wastewater, have researched the correlation between EC and TDS. Research repeatedly shows a substantial positive correlation between EC and TDS, both of which are measures of water quality [5]. TDS measures the total dissolved substances in water, which include salts, minerals, and metals, whereas EC determines the water's capability to conduct electricity, which rises in the presence of dissolved ions [6]. The correlation has been collected in a various type of water, including surface water, groundwater, and drinking water. However, the intensity of this correlation changes depending on the water's source and the content of the dissolved solid [7]. Despite this, EC is still a cost-effective and reliable method for determining TDS levels, especially in developing countries like Bangladesh, which have limited resources for direct TDS testing [1]. In Bangladesh, water pollution from untreated residential wastewater is a major environmental issue. Water contamination is a major concern in the Khulna region, which is quickly urbanizing and industrializing. Domestic wastewater, which contains high quantities of TDS, greatly pollutes local water bodies [8].

However, TDS measurements can be expensive and time-consuming, conducting the use of alternate, more accessible procedures such as EC testing. To determine whether EC can be used as a wastewater quality indicator, this research will find the correlation between EC and TDS in raw domestic wastewater. This correlation could lead to more effective wastewater management and improved public health [2].

Untreated wastewater discharge, agricultural runoff, and industrial contamination have worsened surface water pollution in the Khulna region. Many rivers, lakes, and canals in this region are heavily polluted, threatening human health and aquatic ecosystems. Reducing water pollution efforts are ongoing,

including improvements to wastewater treatment facilities, enforcement of environmental laws, and promotion of sustainable behaviors. Ongoing research is crucial for monitoring wastewater quality and finding ways to prevent surface water contamination [9].

Drinking water quality in Khulna is also a major concern because arsenic and other contaminants, including iron and oli, form bacteria in vicious groundwater sources [10]. To provide safe drinking water, installing deep tube wells and boosting rainwater collection are being researched. However, Surface water sources can be contaminated by industrial discharges and untreated sewage. The government and various NGOs are improving water treatment facilities and ensuring universal drinking water safety to solve these issues.

EC & TDS correlations in many water sources have been consistent (S. Thirumalini & Joseph, 2009) [11]. Other research has shown that EC can accurately measure TDS in surface, ground, and irrigation water (Sattari et al., 2016) [6]. These findings indicate that EC could be used to replace direct TDS measurements in many water quality studies. However, the exact correlation depends on water composition; hence, TDS measurements should still be required for accuracy [7]. Nonetheless, EC is an effective water quality measure, especially in resource-constrained areas like Khulna, Bangladesh, where rapid and cost-effective tests are needed [1].

Domestic wastewater is water used in households for activities such as bathing, dishwashing, and toilet flushing, and it comprises a variety of organic and inorganic contaminants derived from human waste, detergents, and food scraps [3]. Domestic wastewater is produced from residential areas, hotels, hospitals, and schools and causes environmental and health problems if not managed. On the other hand, drinking water is safe for human consumption and must meet quality standards established by organizations such as the WHO and the EPA [11]. Drinking water is commonly acquired from surface water from rivers and lakes, groundwater from wells, and, on occasion, desalinated seawater or recycled wastewater [12].

Surface water is found on the Earth's surface in rivers, lakes, and reservoirs exposed to the atmosphere and collected by rainfall or snowmelt. Surface water is critical for a variety of applications, including irrigation, industrial activities, and drinking water [13]. This water may also flow from subsurface aquifers into rivers and lakes. Surface water safety is

analytical because it is frequently used as a key source for municipal water supplies that are treated to satisfy public health standards [14]. Bangladesh's wastewater treatment is insufficient, with the majority of wastewater untreated due to a lack of infrastructure and funding. Bangladesh largely utilizes primary, secondary, and tertiary treatment procedures. Primary treatment removes large particles and sediments, secondary treatment uses biological procedures to break down organic waste,

and tertiary treatment uses advanced methods such as membrane filtration and chemical treatment to ensure complete purity [12]. However, because of high cost and limited skill, these procedures are rarely used, resulting in untreated wastewater polluting rivers and other bodies of water. Bangladesh is trying to develop treatment facilities and increase public awareness, but wastewater management and water quality protection have many downsides [3].

2. METHODOLOGY

2.1. Water Testing Stations Selection:

This study determines the correlation between EC and TDS concentration in different water sources. In Khulna City, Bangladesh, water was sourced from several locations, such as domestic household water from the basins, drinking water, and surface water. The samples for EC and TDS levels demonstrated a fair correlation between them. The results here prove useful in monitoring and assessing the level of household wastewater EC and TDS for sustainable environmental and human health.

Electric conductivity and total dissolved solids in domestic wastewater are essential for appropriate and economic treatment. Ignoring these parameters makes it challenging to purify wastewater before disposal which invariably increases pollution of the water, soil, and even the air. Such pollution can get into and disrupt the natural ecosystem, endangering loss of biodiversity which would destabilize the fragile balance in nature.

Household drains, basin water, drinking water, and surface water were collected from selected locations in Khulna. The samples were collected from June to August in high-traffic areas such as Shib Bari More, Tetultola More, Moylapota More, Sonadanga Bus Stand, and Sonadanga Residential Area.

Shib Bari More, Tetultola More, Moylapota More, Sonadanga Bus Stand, and Sonadanga Residential Area were chosen for wastewater analysis because they are busy and have many activities that produce wastewater. These places have a lot of people, vehicles, shops, and restaurants, which create different kinds of waste like food scraps, chemicals, and dirty water. Traffic adds oil, grease, and other harmful substances to the mix. In residential areas like Sonadanga, household wastewater, including soap and sewage, also plays a role. All these activities make these areas hotspots for pollution. Studying wastewater here helps us understand the problem better and find ways to reduce pollution.

2.2. Laboratory Testing and Analytical Method Analysis

One hundred twenty (120) samples were taken from the selected locations. After completion of standard sampling procedures, the samples were promptly transferred to the laboratory for analysis within the same day. Each sample was tested individually to provide accurate results and a complete understanding of wastewater quality. A wide range of water quality data from household and public sources was needed to detect contamination levels and perform targeted remediation.

The analysis of these samples indicated considerable contaminants in wastewater, including organic and inorganic compounds, nutrients, pathogens, and

dissolved solids that can endanger human health and the environment. Surface water quality is critical for both ecological and human health and varies in physical, chemical, and biological qualities and must be monitored regularly to ensure it remains suitable for its varied purposes. Drinking water samples were also tested for safety standards since they must be free of hazardous chemicals and meet aesthetic and health criteria before being given to families. Effective treatment techniques are crucial for reducing the impact of pollutants and protecting public health.

Table 1. Water quality parameters, Unit, Analysis Methods

No	Parameters	Unit	Method of Analysis	Measured
1	TDS	mg/ l	Gravimetric Method	Laboratory
2	Electrical Conductivity	µS/cm	Conductivity Meter	Laboratory

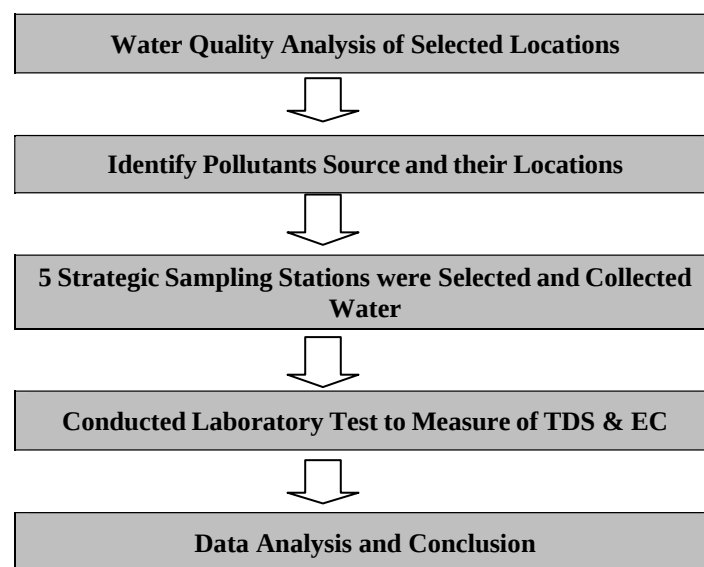
Table 2. Selected Study area with Latitude and Longitude

Sample Station	Area and Location	Latitude	Longitude
S1	Shib Bari More	22°49'20"N	89°33'11"E
S2	Tetultola More	22°48'00"N	89°34'09"E
S3	Moylapota More	22°05'09"N	89°32'17"E
S4	Sonadanga Bus Stand	22°48'59"N	89°32'30"E
S5	Sonadanga Residential Area	22°49'07"N	89°32'42"E

Table 3. The standard values of the parameters derived from ECR'97 and WHO

Parameter	ECR'97 Standard	WHO standard
TDS	500 – 1500 mg/l	1000 mg/l
Electrical Conductivity	> 2500 µS/cm	500 - 1000 µS/cm

2.3. Methodological Approach



3. RESULTS AND DISCUSSION

One hundred twenty (120) water samples were taken from systematically selected various sites inside the Khulna City Corporation throughout October, November, and December, adhering to conventional procedures to assure trustworthy results. Sampling included all accessible wastewater sources, such as

basin water, drinking water, drain water, and surface water, providing a comprehensive picture of water conditions. Each collected sample underwent individual testing, allowing for a full investigation of water quality across these distinct categories.

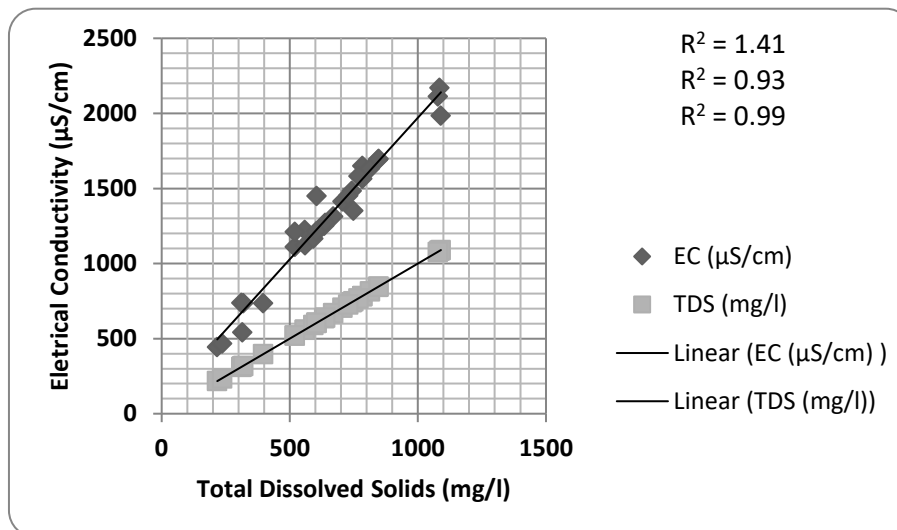
3.1. EC and TDS determinations from Household Basin Water

Table 4 represents a summary of the results found from measuring Total Dissolved Solids (TDS) and Electrical Conductivity (EC). These data are very

important for determining EC and TDS levels for Basin wastewater.

Table 4. Data Analysis of EC and TDS in Household Basin Water from June to August.

Sample	June		July		August	
	EC ($\mu\text{S/cm}$)	TDS (mg/l)	EC ($\mu\text{S/cm}$)	TDS (mg/l)	EC ($\mu\text{S/cm}$)	TDS (mg/l)
1	1353	749	1413	706	1633	814
2	1485	742	1251	635	2112	1078
3	1210	605	738	311	1583	768
4	1566	783	1450	605	1452	728
5	1111	520	1225	559	1166	592
6	2171	1085	1212	520	467	236
7	443	217	1313	670	1270	639
8	1121	560	543	315	1213	604
9	737	396	1985	1090	736	319
10	1691	845	1650	783	1698	847

**Figure 1.** Linear regression Analysis of EC and TDS for Household Basin Water.

3.2. EC and TDS determinations of Drink Water.

The Analysis of Total Dissolved Solids (TDS) and Electrical Conductivity (EC) of Drink Water were conducted during October in the year 2024. The findings are provided in Table 5. The finding of electrical conductivity (EC) and Total Dissolved Solid (TDS) are important. Because these parameters

represent the water's ability to conduct electrical current and total dissolved substance in the drinking water. Since elevated levels might affect flavor, health, and whether water is suitable for consumption, it is vital to evaluate these criteria to determine the quality of the water.

Table 5. Data Analysis of EC and TDS in Drinking Water from June to August.

Sample	June		July		August	
	EC ($\mu\text{S/cm}$)	TDS (mg/l)	EC ($\mu\text{S/cm}$)	TDS (mg/l)	EC ($\mu\text{S/cm}$)	TDS (mg/l)
1	1240	682	478	240	1413	728
2	1485	742	1139	602	1156	572
3	652	326	785	370	1581	792
4	1566	783	1895	949	1137	614
5	1889	949	1312	726	1819	904
6	1412	726	1293	660	783	337
7	1158	574	578	320	1249	624
8	1566	783	1356	683	478	233
9	765	382	1389	759	1879	937
10	1387	668	1925	856	1568	792

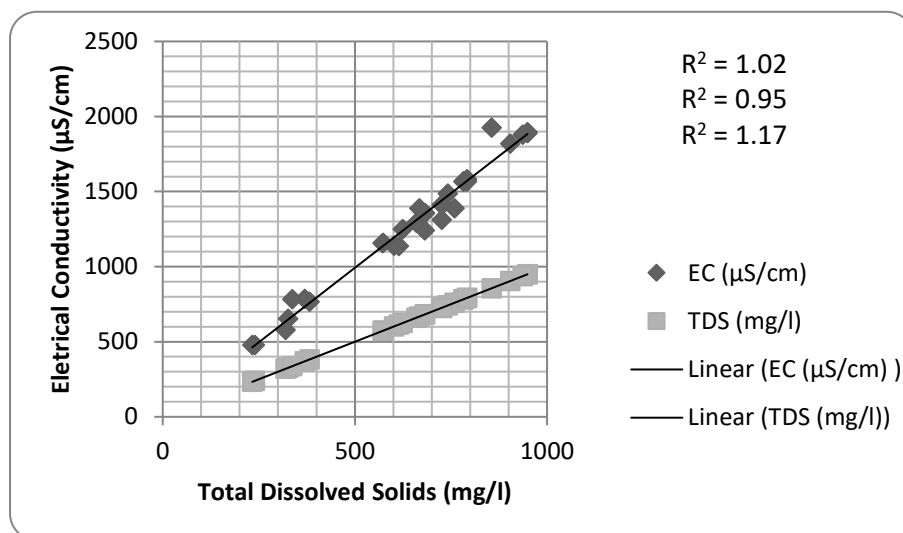


Figure 2. Linear Analysis of EC and TDS for Drain Water.

3.3. EC and TDS determinations of Drain Water

Electrical conductivity and total dissolved solids, in brief, are in close relation with the concentration of solids in the drain water and are presented in Table 6. This data is critical in determining the importance of

EC. This state suggests that the water is capable of transmitting energy, and TDS is the volumetric indicator of all the solids that are in solution.

Table 6. Data Analysis of EC and TDS in Drain Water from June to August.

	June		July		August	
Sample	EC (μS/cm)	TDS (mg/l)	EC (μS/cm)	TDS (mg/l)	EC (μS/cm)	TDS (mg/l)
1	1296	682	1330	665	1696	712
2	1539	769	1205	672	2032	1066
3	1518	759	692	341	1339	648
4	1512	772	1699	720	1205	607
5	1698	717	1557	856	683	349
6	2028	1050	1303	760	1514	758
7	271	170	1440	765	299	182
8	1566	783	375	203	1533	717
9	683	310	2021	995	1518	783
10	2028	1014	2035	1120	1694	853

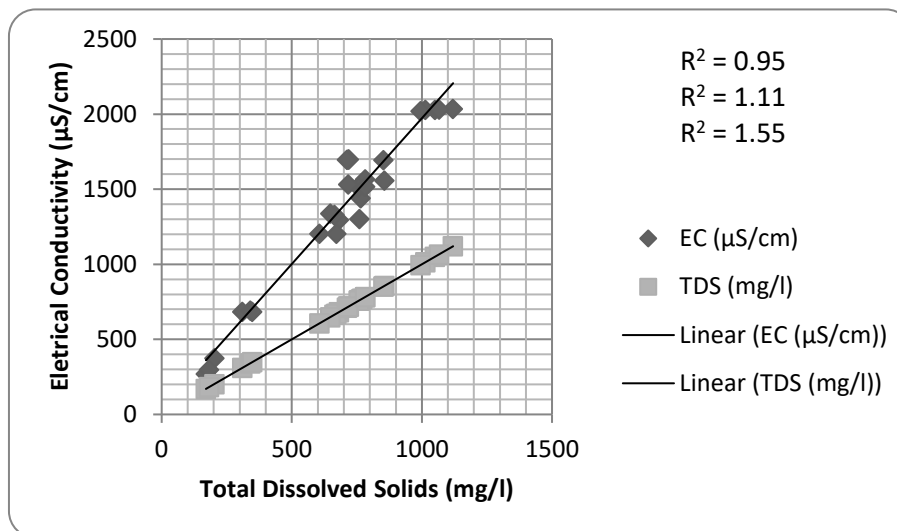


Figure 3. Linear Analysis of EC and TDS for Drain Water

3.4. EC and TDS determinations for Surface water

Table 7 represents the results of Total Dissolved Solids (TDS) and Electrical Conductivity (EC) in the surface water. These data provide important insight

into the magnitude of EC, reflecting water's ability to conduct electrical currents and TDS concentration, indicating the total amount of dissolved substances.

Table 7. Data Analysis of EC and TDS in Surface Water from June to August.

	June		July		August	
Sample	EC (μS/cm)	TDS (mg/l)	EC (μS/cm)	TDS (mg/l)	EC (μS/cm)	TDS (mg/l)
1	998	205	786	393	408	205
2	415	212	3797	1898	997	446
3	409	204	970	493	3498	1752
4	400	200	895	437	648	326
5	648	324	551	310	813	407
6	600	310	508	290	974	438
7	792	396	792	396	613	309
8	3647	1823	3503	1722	788	393
9	811	405	785	370	451	233
10	786	393	865	430	792	398

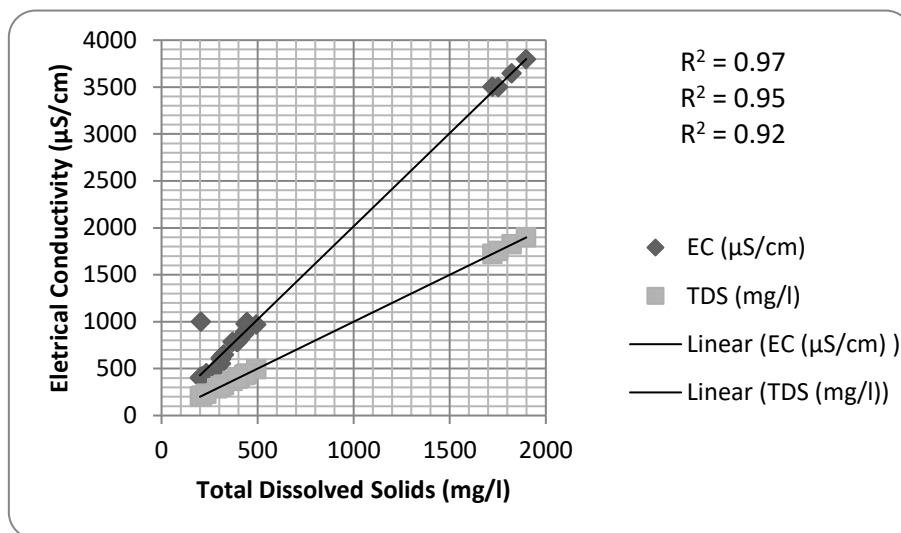


Figure 4. Linear regression Analysis of EC and TDS for Surface Water.

3.5. Correlation Coefficients for all Water Sample

[Table 8](#) shows the correlation coefficients for Total Dissolved Solids (TDS) and Electrical Conductivity (EC)

Across all water samples, providing data into the relationship between these key water quality parameters.

Table 8. Correlation Coefficients for all Water Sample

Time/Sample Name	Basin Water	Drinking water	Drain Water	Surface Water
Safe Range	1+	1+	1+	1+
October	1.41	1.02	.95	0.97
November	0.93	0.95	1.11	0.95
December	0.99	1.17	1.55	0.92

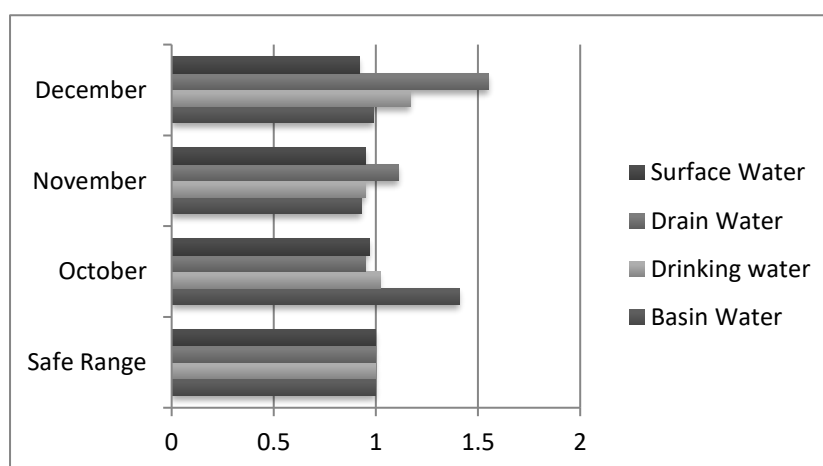


Figure 5. Correlation Coefficients Analysis for all Water Samples in Khulna City

The data from [Tables 4–7](#) display mean values derived from triplicate measurements, highlighting the seasonal changes in electrical conductivity (EC) and total dissolved solids (TDS) observed from June to August. During October, the electrical conductivity (EC) showed a range from 3647 $\mu\text{S/cm}$ to 271 $\mu\text{S/cm}$, while the total dissolved solids (TDS)

values jumped from 170 mg/L to 1823 mg/L. The values recorded in November show a range for EC from 3797 $\mu\text{S/cm}$ to 478 $\mu\text{S/cm}$, while TDS difference between 1898 mg/L and 240 mg/L. In August, the electrical conductivity (EC) difference between 3498 $\mu\text{S/cm}$ and 299 $\mu\text{S/cm}$, whereas the total dissolved solids (TDS) fluctuated from 1752

mg/L to 182 mg/L. The electrical conductivity (EC) showed a range from 3797 $\mu\text{S}/\text{cm}$ to 271 $\mu\text{S}/\text{cm}$, while the TDS varied from 1823 mg/L to 170 mg/L. That indicates a consistent upward trend in both metrics over the observed months (Greener Journal of Physical Sciences, Vol. 3 (3), April 2013).

Elevated EC values reflect substantial levels of inorganic ions (e.g., H^+ , Na^+ , K^+ , Mg^{2+} , Ca^{2+} , Cl^- , SO_4^{2-} , HCO_3^-), which affect the conductivity of water. The increased TDS levels indicate a significant presence of dissolved solids. Which likely

surrounds organic matter resulting from stormwater runoff and dissolved nutrients, including carbohydrates, proteins, and mineral salts.

Linear regression analysis (Figures 1–4) shows a positive, proportional relationship between EC and TDS, with correlation coefficients nearing +1 ($r = 1.41, 1.02, 0.95$, etc.), signifying a robust positive correlation. This indicates that increases in EC are associated with rises in TDS. This makes the connection between these factors in the wastewater and open water that was studied stronger.

4. COCNLUSION

Elevated electrical conductivity (EC) values indicate a significant presence of TDS in water. It has been found that the concentration of dissolved ionic solutes is directly correlated with water conductivity. Consequently, elevated EC values signify increased concentrations of dissolved substances. The correlation between TDS and EC is significant, as the presence of dissolved solids directly affects the electrical conductivity of water.

EC and TDS serve as essential parameters of water quality. EC and TDS are frequently utilized in

wastewater treatment, industrial applications, agriculture, and for the finding of wastewater, drinking water, and surface water quality. The evaluation of these metrics provides insights into salinity levels and the detection of contaminants, which is essential for evaluating water safety for consumption or various applications.

Results of the study show that both EC and TDS went up during the study time, which could mean that the water quality isn't safe.

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AUTHORS CONTRIBUTION

This work was carried out in collaboration among all authors.

CONFLICT OF INTEREST

The author (s) declared no potential conflicts of interests with respect to the authorship and/or publication of this paper.

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